Reponses to US Environmental Protection Agency (EPA) July 31, 2015 Comments on the July 6, 2015 Work Plan for Additional Characterization of Extent of Radiologically-Impacted Material in Areas 1 and 2, West Lake Landfill Operable Unit-1, Bridgeton, Missouri

EPA General Comments:

1. The parties need to ensure there is a clearly stated priority for completion of the 25 borings associated with the Area 1& 2 RIM calculations to ensure timely completion of the Area 1and Area 2 characterization activities and final report. If necessary, separate mobilizations should be performed if the proposed Fate & Transport (F&T) and Radon Flux sampling will cause any delay for the additional Area 1& 2 effort, as this data is key in moving other documents forward related to the pending remedy decision. Delays would include submission and approval of key document revisions to EPA (i.e., QAPP).

Response: *Explicit statements will be added to the end of the Field Investigation and Sample Collection and Analyses and the Schedule sections of the work plan indicating that completion of the 25 borings and associated sample collection and laboratory analyses required to define the extent of RIM is the highest priority for the additional investigation.*

2. Determine if any of the proposed additional sampling impacts or changes DQOs and the associated existing documents (QAPP, Site Health and Safety Plan). If so, please submit the revised documents and supporting materials for EPA review as soon as possible.

Response: *The QAPP and the associated DQOs may need to be updated to address collection of additional samples for laboratory testing and analyses to support the Fate and Transport evaluations. Amendments/revisions to the DQOs and QAPP addressing these additional analyses can be prepared concurrently with the site preparation work and the initial stages of drilling and sampling.*

EPA Specific Comments:

1. Page 2, <u>Scope of Work and Objectives of the Investigation</u>, last sentence of first paragraph - Please revise to state "The proposed drilling locations will be relocated as necessary prior to the start of drilling activities based on potential physical constraints to drill rig access "<u>with prior EPA coordination and approval</u>"."

Response: *Per EPA's comment letter, the response to this comment was previously submitted to EPA on August 4, 2015. This response has not changed or been modified significantly (other than correction of a few minor typographical/grammatical errors) since that date and is included below for completeness as provided on August 4.*

The proposed revision is acceptable assuming that either the On-Scene Coordinator is on-site and available to evaluate any proposed changes or the Remedial Project Manager is available via e-mail or telephone at the time any proposed changes may be identified.

2. Page 3, <u>Field Investigation and Sample Collection and Analyses,</u> Item #2

Note: Per EPA's comment letter, the response to each of the items included in this comment were previously submitted to EPA on August 4, 2015. These responses have not changed or been modified since that date and are included below for completeness as provided on August 4th.

a. First sentence of third paragraph - revise the word "may" to "will" (... one or more sediment samples will be obtained.)

Response: *The proposed change is acceptable.*

b. Identify the sampling locations on the respective Area 1 figure. This sediment sampling effort should take into consideration prior RI sediment sampling locations.

Response: *Revised versions of Figures 1 and 2 that identify the potential sediment sampling locations are included with these responses to comments. These locations are proposed as a contingency, in case of a major precipitation event that could potentially erode soil from any areas subject to vegetation clearing and road/drill pad construction activities. The three sediment sampling locations (SED-1, SED-2 and SED-4) shown on Figures 1 and 2 are locations from which sediment samples were obtained during the Remedial Investigation (RI). The fourth location from which sediment samples were obtained during the RI (SED-3, shown on Figure 2) was located along the northeast side of the Closed Demolition Landfill and is not proposed for sampling because transport of sediment from Area 1 or 2 would first pass through either the SED-1 or SED-2 locations, which are included in the contingent sediment sampling effort.*

Note: No Specific Comment 2.c. was provided.

d. Discussion in text needs to explain in detail the steps for vegetation clearing, to include size/height/method for its removal. Also, the text should discuss what weather conditions would halt field activities.

Response: *The following description of the brush removal activities used during the Phase 1 investigation is provided in response to this comment. These are the same procedures that are anticipated to be used to support site preparation for the Additional Investigation of Areas 1 and 2 with the following additions:*

1) *The contractor may employ a skid steer with a forestry cutter attachment. This attachment can cut and grind woody vegetation with the same piece of equipment. The woody vegetation will be*

moistened with a water cannon prior to grinding if necessary to minimize chipping dust. Please note this attachment will grind the vegetation close to the ground surface, but will not grind roots into the ground, and therefore, the underlying soil will not be disturbed from this attachment.

2) *Any significantly sized woody vegetation (approximately 1-inch in diameter) that is cut by the tree shears will be chipped in a wood chipper and the chipped woody vegetation will be placed on the road paths prior to geotextile deployment.*

   The brush clearing was accomplished by using a skid steer rotary brush and tree cutter. Prior to using the rotary brush cutter, a demonstration of this machine was provided to the EPA On-Scene Coordinator to show that the machine would not generate dust if operated with moist vegetation. While the natural dew provided this moisture during the demonstration, a water truck was made available during the entire clearing operation to add moisture, if needed, to the vegetation. The rotary brush cutter was attached to the front of a track-mounted skid steer tractor, so the cutting and grinding platform advanced ahead of the tractor and operator. The operator placed the cutting surface a few inches above the ground surface, and the ground wood chips were coarsely ground and left in place. This method provided an adequate surface for the geotextile.

Vegetation clearing and road/drill pad construction activities will not be scheduled during periods when severe thunderstorms or major precipitation events (rainfall of a rate of over ½ inch per hour) are forecast for the site area or when observations by on-site personnel indicate a potential for a severe thunderstorm or major precipitation event.

e. Clearly define locations on figures that show those borings referenced in the text with the highest runoff potential, and the proposed/associated sampling locations should it occur during clearing or following a significant precipitation event.

Response: *As stated in the third sentence of the second paragraph of item no. 2 on page 3 of the Work Plan, the two locations with the highest potential for soil erosion are locations 6 and 7 which are clearly identified on Figure 1. We are unclear what additional designations are necessary to clearly define these two locations. Soil that may be eroded from either of these locations could potentially be transported down the slope of Area 1 to the perimeter drainage ditch located along the south side of the main Bridgeton Landfill/Transfer Station access road. RI sediment sample location SED-1 is located within this drainage ditch at the northeast corner of Area 1 and therefore is downslope/down-drainage from the two locations (Borings no. 6 and 7) with the highest potential for offsite soil transport in the event a major precipitation event were to occur after the vegetation had been cut but before the geotextile and road base material has been placed.*

f. Elaborate in the text that clearing of vegetation for collection of these additional samples is limited with regards to overall site size, and shall use methods previously employed during the Phase lD that were observed by federal and state regulators and have presented no issues to date.

Response: *The extent of the anticipated vegetation clearing is very small, approximately a quarter acre*

in Area 1 and approximately one acre in Area 2. Please note that a large portion of the anticipated road/drill pad construction in Area 2 is expected to occur over areas where inert fill was previously placed where no vegetation clearing is expected to be needed.

As stated in the first paragraph under item no. 2 on page 3 of the Work Plan: "Vegetation removal and construction of access roads and drill pads will be performed using the procedures previously employed for these activities during the prior Phase 1 and Phase 1D investigations in Area 1. Specifically, the vegetation will be cut near but above the ground surface using a "brush hog" and/or a skid steer with a vegetation cutter or a forestry grinder attachment without disturbing the underlying ground surface or vegetation roots. The vegetation cuttings will be chipped and placed on the ground surface. A geotextile will be laid on top of the cleared area and vegetation chips over which approximately 8 inches of road base material will be placed." The following sentence will be added to this discussion: "These activities were used during Phase 1 and Phase 1D during which representatives of federal and state regulators observed the procedures and no issues were identified."

g. Clearly identify actions that will be taken, and/or will be readily available for deployment, in the event of a sudden precipitation event that could result in migration of sediment/surface water from these areas (booms, silt fences, etc.) to ensure a potential release is mitigated. These actions should particularly focus on borings that are close to existing concrete drainage structures along the facility main roadway.

Response: *Clearing of vegetation and construction of roads and drill pads will not be performed in or around drilling locations no. 6 and 7, or at any other locations which, based on field observations by on-site personnel at the time of initial location and surveying of the drilling locations or during the site preparation work, where a potential for soil erosion during periods of significant precipitation events exists. Additional geotextile material will be available to temporarily cover any exposed areas in the event that a significant precipitation event were to occur after the vegetation had been cut but before placement of the geotextile and associated roadbase material. Lastly, hay bales or straw wattles will be placed adjacent to the perimeter drainage such that they can be rapidly installed across the perimeter drainage to restrict erosional transport of soil in the event of an unanticipated precipitation event that results in potential soil erosion.*

3. Page 5, <u>Field Investigation and Sample Collection and Analyses</u>, Item #6, last sentence of paragraph - Section needs to explain how the multiple lines of evidence will be compared to determine difference between LBSR and other wastes disposed at the site.

Response: *The analytical results of samples with elevated alpha and/or gamma readings will be reviewed to evaluate the potential source of the observed radiation (e.g., radium, thorium, potassium-40, etc.). Samples with radium and thorium levels above the unrestricted use criteria will also be assessed for the relative proportions of radium-226 to radium-228 and thorium-230 to thorium-232. RIM associated with LBSR should contain substantially higher levels of radium-226 and thorium-230, whereas samples containing naturally occurring radium and thorium should contain a higher proportion of radium-228 and thorium-232. Samples associated with LBSR also are likely to contain higher proportions of*

thorium-230 compared to radium-226, which is reflective of the secular disequilibrium in these radionuclides resulting from historic processing of ore material for uranium recovery that resulted in production of the LBSR. Additionally, chemical data will be used to further differentiate the presence of non-LBSR RIM.

4. Page 5, Field Investigation and Sample Collection and Analyses, Item #8, last sentence of paragraph -Text indicates that F&T samples shall be collected from 4 borings in Area 1and 6 borings in Area 2. Please reference a figure demonstrating these borings and ensure they are identified on the related figure(s).

Response: *The specific samples will be selected from borings/core intervals that display elevated downhole gamma readings and/or elevated core scan alpha and gamma readings. Identification of such samples cannot be performed until the field work is conducted.*

5. Page 7, Field Investigation and Sample Collection and Analyses, Item #9 -The geotechnical sampling locations proposed under this section need to be identified and referenced within the text and by figure. Explain how the sample locations will be distributed across the site in order to obtain the best representation of site soils. As discussed with EMSI in a prior conversation, the field method for deploying a "Shelby" tube sampler also needs to be confirmed and discussed in the document prior to its approval. EPA recommends performing this effort with a separate drill rig, as this method is readily available on many rotary-type drill rigs, and to ensure the additional data collection does not impede other sampling scheduled for the sonic drill rig (see General Comment 1).

Response: *Upon further evaluation and discussion with EPA, we have determined that collection of samples and performance of geotechnical testing to support radon emission calculations is not required as part of the additional characterization of Areas 1 and 2. Prior RI sampling included collection of actual radon emissions from the surface of Areas 1 and 2 and therefore no additional data are necessary to evaluate current radon emissions. For those remedial alternatives that include leaving all or some of the RIM in Areas 1 and 2, the design of a new engineered landfill cover to be installed over Areas 1 and 2 will include evaluation of the thickness and types of materials necessary such that future radon emissions will not exceed standards associated with relevant and appropriate requirements of other environmental regulations or risk-based levels. The only potential need for geotechnical testing to support radon emissions calculations is associated with a possible isolation barrier, and even then would only be appropriate for areas where a low permeability landfill cover with sufficient radon attenuation capability is not installed. No such areas are expected to occur because an appropriate landfill cover would be installed over any portions of Areas 1 and 2 where RIM may be left on site as well. Furthermore, an engineered landfill cover will also be installed over the above-grade extent of the North Quarry portion of the Bridgeton Landfill that overlies the Bridgeton Landfill. Consequently, pursuant to EPA concurrence and approval, all references to collection of samples for geotechnical testing to support radon emission calculations will be deleted from the Work Plan for Additional Characterization of Areas 1 and 2.*

6. Page 9, Reporting - EPA's expectations for reporting are as follows:

a. Phase 1GCPT/Sonic investigation report -This report updates the December 2014 draft deliverable and comprehensively includes all phases of this effort in Area 1 (including the most recent Phase lD). A separate Phase lD data report is not required and is redundant. Listed here only for clarity as it was specifically referenced within this work plan and the draft report for this submittal should be provided to EPA for review within 30 calendar days of receiving the validated analytical data.

b. Area 1 and 2 Data Report - This report shall provide the data relevant to the 25 sampling locations and other results that are pertinent to completing the upcoming deliverables for Area 2 RIM Volume and Partial Excavation Evaluations, and should contain only the data, figures and documents relevant to this pending fieldwork effort (e.g., cover letter, figure and data tables); and the draft should be provided to EPA for review within 30 calendar days of receiving the validated analytical data. Data and results collected for the radon-flux and F&T purposes shall be submitted to EPA as separate submittals,

c. Comprehensive Report - As previously addressed by EPA in the Phase lD work plan addendum review, please delete references to a final comprehensive report as part of this work plan. In the near future EPA will propose to the PRP group a path forward for incorporating all additional data collected under the Phase 1GCPT/Sonic drilling, Area 1 & 2 additional sampling and other relevant new information into the existing Remedial Investigation Report.

Response: *Comment noted. References to a Phase 1D Data Summary Report will be deleted from the work plan and presentation of the results of the Phase1D investigation will be included in the Comprehensive Phase 1 Report. Compilation and submittal of the results of the Additional Characterization of Areas 1 and 2 will be presented in an Additional Characterization of Area 1 and 2 Data Summary Report. All references to a comprehensive report based on the results of the Phase 1, Phase 1D and the additional Area 1 and 2 investigations will also be deleted from the report. A schedule for preparation of an RI Addendum will be developed once the full content of such an addendum is discussed with EPA.*

With respect to the 30-day time frame after receipt of validated data specified by EPA for submittal of Comprehensive Phase 1 Report and the Additional Characterization of Areas 1 and 2 Data Summary Report, the Respondents believe that such a schedule is not feasible. We anticipate that upon receipt of the final data validation reports and an updated electronic database, it will take approximately one week to prepare summary tables and figures of the analytical results, followed by a week of review, evaluation and revisions of these tables and figures to develop interpretations of the results and revised tabular and graphic presentations, followed by a minimum of one week (more likely two weeks) to prepare narrative text and assemble a draft report, followed by two weeks for client review, one week for revision, and one final week for final review and assembly and production of the report. Therefore, it is our opinion that in order to prepare a complete and comprehensive report, we will require at least eight (8) weeks from receipt of validated data to produce these reports. It is our opinion that even this schedule is highly optimistic and does not build in an additional cushion for potential delay; however, we understand EPA's desire to move as quickly as possible. Therefore, will revise the schedules to reflect an eight-week period

from receipt of validated data until submission of draft reports to EPA.

7. Page 9, Reporting - Sub-item #2. References the 1971-1975 topographic elevations are only relevant to Area 1, and as recent sampling has demonstrated, is not entirely relevant to RIM locations other than as a planning tool for completing the Phase lD effort or general reference.

Response: *References to the 1971-1975 topographic elevations included in the work plan were discussed in the context of a comprehensive report which per EPA comment no. 6(c) is being deleted from the scope of the current work plan but may be considered at a later date. Accordingly, reference to the 1971-1975 topographic elevations will be deleted at this time.*

8. Page 10, Schedule -Activities listed in the schedule are linear (start to finish) and overestimated for duration by approximately 5 to 6 weeks, depending on outcomes. Several items overlap with regards to starting sequences and which, is planned accordingly, can shorten anticipated durations. In general overall schedule could be compressed if managed for non-linear activities. Specifically:

Response: *Although we understand how EPA reached the conclusion that the activities listed in the schedule are linear, that is not actually the way the schedule was developed. The schedule was actually based on a finish-finish relationship plus a certain number of additional days as are needed to complete each task. For example, the six weeks included in the schedule for laboratory analyses actually only represents the six-week period from submission of the last sample to the laboratory (i.e., completion of the predecessor task of drilling, geologic logging, core logging and selection of samples for laboratory analyses). The actual duration of the laboratory analyses is more on the order of fourteen weeks, based on submittal of the first samples for laboratory analyses approximately two weeks after the start of drilling, logging and scanning activities and completion of the laboratory analyses approximately six weeks after receipt of the last sample. The schedule included in the work plan will be revised to reflect the actual, entire duration of each task.*

a. Construction of drill pads once mobilized can overlap by 2 weeks with planned fieldwork drilling without interfering and shorten schedule (naturally assumes EPA's approval for performance of the effort but based on substance of Agency's comments, EPA reviewer assumes this is probably for schedule purposes).

Response: *The Respondents and their contractors will consider overlapping the beginning of the drilling with the latter stages of the site preparation work. Such an overlap is subject to the availability of sufficient qualified personnel (e.g., health physicists) needed to support concurrent activities at the time these tasks are performed and also on the availability of the drilling contractor.*

b. Fieldwork can be significantly reduced if overlap with field prep activities (assume 2 weeks if drilling crews can be coordinated), consider other methods of drilling that can be more flexible than sonic and allow for greater availability of drilling resources (rotary methods and consider increasing productivity with multiple crews; assuming support resources such as site HPs are

available to staff necessary field actions). As stated above, ensure Area 1& 2 data collection has priority as laboratory time is greatest for radionuclides versus other methods and should be completed first.

Response: *As discussed in the response to the previous comment, the Respondents and their contractors will consider overlapping the beginning of the drilling with the latter stages of the site preparation work, but subject to the availability of key personnel and the drilling equipment.*

We are in the process of evaluating alternative drilling and sampling methods that, if they can be implemented, and if they can produce sufficient core recovery, may reduce the overall duration of the drilling activities. We offer the following discussion relative to use of alternative drilling methods.

The primary method for drilling and core recovery (Sonic Drilling) identified in the Phase 1 work plan was Rotosonic (Sonic) drilling. Use of a percussion geoprobe method was included for discrete sample interval recovery. For the additional characterization work we are requesting that in addition to the Sonic drilling method, that EPA approve use of both a rotary auger method and a percussion geoprobe method for the drilling and coring.

The rotary auger will use a hollow stem auger with a minimum 6" outer diameter (maybe greater diameter subject to availability). The auger will be advanced with a continuous tube sampler system, and the tube sampler will be lined with two (2) 30" clear plastic liners which will be used inside the tube sampler to retain the sample. The use of the clear plastic liners allows the visual examination of the sample in the field. The rotary auger method will generate cuttings which will be disposed within the OU-1 area next to the drilling site. The cuttings will be leveled and covered with an 8 ounce geotextile and 8 inches of gravel (the same gravel that will be used in the road building effort). The rotary auger will be scanned and dry decontaminated between borings.

The percussion or direct push method would use a Geoprobe 8040-DT with DT-45 tooling that is 4.5"O.D. The DT45 advances a 3"x 5" continuous clear plastic liner within the waste mass using an outer steel casing. This system uses percussion vibration to advance the casing, then the casing sampling tube is ejected from the casing. This method does not generate any cuttings for disposal. The percussion geoprobe casings will be scanned and decontaminated between borings.

Both the rotary auger method and the percussion geoprobe will advance the auger / casing through the entire profile of waste. Once the bottom of waste has been verified, a 2" PVC pipe will be installed in the borehole to conduct the downhole gamma scan. Once the downhole gamma scan has been conducted, the PVC casing and associated sand placed in the bottom portion of the hole will be removed and the auger / drill casing will be reinstalled to the entire depth of the boring. The boring then will be grouted in accordance with the previously approved methodology using a tremie pipe.

As stated in response to EPA General Comment No. 1, explicit statements will be added to the end of the Field Investigation and Sample Collection and Analyses and the Schedule sections of the work plan indicating that completion of the 25 borings and associated sample collection and laboratory analyses required to define the extent of RIM are the highest priority for the additional investigation. Samples for radionuclide analyses and for chemical analyses are collected at the same time from the same core sample intervals. Sample collection is performed upon completion of the downhole gamma logging and the geologic logging and scanning of the core samples. This work is performed as quickly as possible

subject to constraints posed by the need for personnel (e.g., rig/field geologist, health physicist, etc.) to support multiple ongoing activities.

c. Laboratory Analysis, Data Validation will have overlap as data packages can be processed, analyzed and validated as the data become available. Sample analysis for the Area 1 & 2 radionuclides will have the longest duration for receiving validated results, which justifies their priority for completion.

Response: *Data validation activities begin as soon as complete data packages are provided by the laboratories. As discussed in the response to EPA specific comment no. 8, the schedule presented in the work plan was based on a finish-finish relationship. In this case, data validation is expected to be complete within three (3) weeks of receipt of the last analytical reports/laboratory data packages; however, actual data validation activities will begin upon receipt of the first laboratory data package. The schedule in the work plan will be revised to reflect the ongoing nature of the data validation and other activities.*

d. As with data validation packages, field data can obviously be systematically processed (logs, figures, tables, text, etc.), which can ultimately reduce this timeframe and typically overlaps with other activities.

Response: *Preparation of field data deliverables (e.g., final boring logs, final downhole logs, final core scan logs, etc.) will begin upon completion of the field investigation activities (i.e., the drilling, downhole logging, core logging and core scanning) and will occur concurrently with the period in which laboratory analyses and data validation occur after collection of the final samples. The schedule included in the work plan will be modified to reflect this overlap. It should be noted that this procedure is the same procedure that was being used to prepare the now-deleted Phase 1D Data Summary Report and will be used to prepare the Phase 1 Comprehensive Report.*

e. Last item - comprehensive report (see comment 6c above). While projection may or may not be accurate, it needs to consider overlap with other data sources that will allow for this report to be developed in stages (Phase 1, Area 1and 2, etc.), and will certainly be a key deliverable for discussion/clarification in the pending technical meeting and AOC modification.

Response: *Per EPA specific comment no. 6, all references to a comprehensive report of the results of the Phase 1, Phase 1D and Additional Area 1 and 2 investigations are being deleted from the work plan.*

USGS General F&T Comments:

The proposed additional characterization of solid materials and the leaching tests will provide data that should aid in reducing uncertainty about the origin of Ra and other radionuclides and provide some boundaries for FT modeling. However, it is unclear at this point if the proposed

characterizations will provide enough information to conclusively differentiate RIM from other sources of radionuclides as is stated on page 9. The sample set will still be relatively small and it seems no samples of MSW are to be subjected to the same procedures as high gamma and the "lower" samples that will be collected.

Response: *It is possible that the data may not provide a basis to conclusively differentiate sources of RIM. In the event that a clear differentiation cannot be made, subsequent evaluations will presume that all occurrences of radionuclides above particular trigger levels (e.g., levels established by EPA for "complete rad removal" alternatives or for partial excavation alternatives) will be included in the scope of subsequent evaluations.*

The plan seems to ignore the possibility that perched water may exist within the materials cored. Analysis of water in these zones could provide additional information regarding the mobility of radionuclides and nature of the landfill leachate in areas 1and 2. In addition, comparison of perched water beneath and perhaps above or from areas known not to contain RIM would be informative.

Response: *Perched water samples were obtained from a few locations during the RI investigations and were previously subjected to laboratory analyses. The results of the analyses of these samples are documented in the RI report and related field investigation reports prepared by McLaren Hart. The results of these analyses will be considered during performance of the fate and transport evaluations. To the extent that the additional investigations identify potential occurrences of perched water, which may be difficult depending upon the drilling technique employed (i.e., Sonic drilling may require introduction of water for heat control), collection of samples of any perched water that may be encountered and identified may be attempted. Collection of perched water samples will require stopping drilling for the period of time it takes for the perched water to flow into and accumulate in the boring and for collection of sample volumes. Therefore, collection of such samples could impact the drilling schedule. Samples would be collected using disposable bailers and submitted for the same analytes as are being included for the soil/waste samples, plus total dissolved solids and total suspended solids.*

The list of additional elements should be expanded even beyond those listed in paragraph #6. There is a standard 55-element list that often is determined in soil samples by USGS that is of reasonable cost and may provide additional elements from which fingerprinting LBSR from other RIM materials may be possible. The assumption here is that there are results from known LBSR and other RIM materials from which to compare correct? Maybe from the site from which the RIM originated?

Response: *The list of metals included as analytes in the work plan is the EPA standard Target Analyte List (TAL) for metals. We are not aware of how the other metals included on the standard USGS list may provide data that could be useful in differentiating RIM from other potential sources of radionuclides.*

We are not aware of any results from known LBSR or other RIM to which we can compare the analytical data. The LBSR originated at the Mallinckrodt Downtown site and was then moved to the St. Louis

Airport Site where it was stored for a period of time, then moved to the Latty Avenue site, where it was also stored for a period of time. The LBSR was then mixed with surface soil from the Latty Avenue site and delivered to the West Lake site. We are not aware of any analytical results for the LBSR itself, or the LBSR mixed with soil prior to sampling performed at the West Lake Site.

It would seem that selection of waste materials NOT having elevated gamma counts or samples from several borings not thought to have RIM would provide additional supportive information regarding the potential from elevated radionuclides from MSW as described on p 9. Perhaps additional considerations should be given to the "lower sample" mentioned in #5.

Response: *Samples will be obtained from all borings, including any that do not display elevated gamma readings. Samples were previously obtained from borings drilled during the Phase 1D investigation that did not display elevated gamma readings and were submitted for the same analytical parameters that are proposed for use for the Additional Characterization of Areas 1 and 2. Lastly, it is likely that as part of the additional characterization effort there will be some boreholes or borehole intervals that will not display elevated gamma readings but will nonetheless be submitted for laboratory analyses (e.g., the work plan specifies two samples per boring for laboratory analyses regardless of gamma readings).*

Selection of sequential extraction procedures (SEP) is critical and data from SEPs is not as clear cut as might be assumed. Elements can redistribute themselves and results have to be considered as but one line of evidence (e.g. see Zimmerman and Weindorf, 2010 International Journal of Analytical Chemistry) (see referenced attachment).

Response: *We concur that some small fraction of the targeted elements can redistribute during the SEP, and for this and other reasons consider the SEP to be only one of a multiple-lines-of-evidence approach as described in the plan which also includes XRD, EMPA, and simulation of the leaching tests using the inferred mineralogy.*

While it is understood that characterization methods are still being evaluated, other protocols in the geochemists toolbox may be useful-gravity and magnetic separation of solid materials, Gandalfi-XRD, is fission track useful in this setting?

Response: *While there may be value to the identified methods, the proposed work plan already incorporates multiple lines of evidence that are consistent with recommendations of EPA (e.g., Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Vol. III: Assessment for Radionuclides Including Tritium, Radon, Strontium, Technetium, Uranium, Iodine, Radium, Thorium, Cesium, and Plutonium-Americium, USEPA-600-R-07-140). The possible exception would be gravimetric separation as a method for separating uranium and thorium.*

It is unclear if the additional samples for FT in #8 are collected from the same locations as those in #6. If the locations are different then it is unclear why the FT samples in #8 are not subjected to all the testing done on #6 in addition to the extra characterization mentioned in #8.

Response: *Because the focus of the fate and transport related testing is on the occurrence, distribution and leachability of radionuclides, we expect that, subject to the availability of sufficient core material, the sample intervals selected for the fate and transport related analyses will be obtained from the same core sample intervals as the samples obtained for characterization of radionuclide occurrences under step no. 6.*

Reporting limits for 55 elements by ICP-AES-MS (enclosed for reference):

Response: *Comment noted.*

USGS - Specific F&T Comments:

1. Page 5, Field Investigation and Sample Collection and Analyses, Item #6, third sentence - The inclusion of additional elements, especially RRE that may be used to fingerprint a true RIM single. The list probably should be expanded to include a larger suite of elements perhaps using ICE-AES-MS (see attached standardized 55 element list). Na and Si would need to be determined by another method.

Response: *This suite of elements is not planned to be incorporated within the F&T modeling for purposes of simulating the likely fate of radium: so, for that express purpose, knowledge of these additional elements would not be necessary. Knowledge of these additional elements may be useful for discriminating between different sources of RIM-bearing material.*

2. Page 6, Field Investigation and Sample Collection and Analyses, Item #8, first paragraph, last two sentences - (It is) Unclear how the last two sentences can be reconciled. First samples are vacuum- sealed to preserve oxidation state but then samples are air-dried and homogenized.

Response: *The samples will be dried and homogenized in a glovebox under a positive-pressure argon atmosphere. The text of the work plan will be amended to clarify this.*

3. Page 6, Field Investigation and Sample Collection and Analyses, Item #8, third bulleted item/redox indicators - (It is) Unclear how redox indicators are to be determined in solid samples.

Response: *Sulfide will be analyzed via EPA Method 9024; iron speciation will be determined by chemical extraction, such as Method SM 3500F; uranium-6 will be determined using a sodium-bicarbonate solution as detailed in USEPA-600-R-07-140.*

4. Page 6, Field Investigation and Sample Collection and Analyses, Item #8, sixth bulleted item/Sequential extraction -The reference to Liu (2011) could be a good analogue to how Ra in RIM

(assuming the Ra is from neutralization of U-ore digestion). However, there is ambiguity in Sequential extraction procedures (SEP) and results can be difficult to interpret and not as clear cut as the brief text here might indicate. Liu (2011) does not provide any rationale why they selected the particular SEP they used. Zimmerman and Weindorf (2010) indicated that many elements in SEP actually redistribute themselves during the process such that elements released in the initial steps reattach to newly available sites of the next fraction. Clay minerals also can be greatly modified during the initial SEP steps. The text here does not seem to indicate that results from the SEP may be ambiguous. SEP results should not (be) used by themselves to assign Ra phase associations. XRD with Gandolfi XRD of individual grains can help. Perhaps consideration to gravity and magnetic separation of grains followed by detailed Gandalfi XRD and SEM with EDS/WDS X-ray.

Response: *While there may be value to the identified methods, the proposed work plan already incorporates multiple lines of evidence that are consistent with recommendations of USEPA (e.g., Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Vol. III: Assessment for Radionuclides Including Tritium, Radon, Strontium, Technetium, Uranium, Iodine, Radium, Thorium, Cesium, and Plutonium-Americium, USEPA-600-R-07-140). The possible exception would be gravimetric separation as a method for separating uranium and thorium.*

5. Page 7, <u>Field Investigation and Sample Collection and Analyses</u>, Item #8, eighth bulleted item/Cation Exchange Capacity (CEC) - This is a rather simplistic view of CEC and Ra geochemistry is considerably more complicated that simple relations to CEC.

Response: *As stated in response to an earlier comment, SSP&A concurs that some small fraction of the targeted elements can redistribute during the SEP, and for this and other reasons considers the SEP to be only one of a multiple-lines-of-evidence approach as described in the plan. Other lines of evidence include the results of the XRD and EMPA analyses, and simulation of the leaching tests using the inferred mineralogy. However, it is also noted that the proposed SEP method is effective at targeting extraction from those phases that are of particular interest in this characterization (i.e., radionuclide leachability from iron oxyhydroxides, carbonates and barite).*

6. Page 9, <u>Reporting</u> - Sub-item #2 - Unclear (to the reviewer) how this will be done as how accurate the 1971-75 topographic elevations; also, if RIM-type materials were readily discernable in aerial elevations since they could not discriminate elevations at resolution below 2-feet intervals.

Response: *See our response to EPA specific comment no. 7. References to the 1971-1975 topographic elevations will be deleted from this work plan.*

7. Page 9, <u>Reporting</u> - Sub-item #3 -This is a first step. However, the work plan does not seem to characterize radium in other MSW materials so results may not be conclusive. Likewise, leachability of Ra from MSW is not known nor leaching of Ra from native soils and aquifer materials.

Response: *Discerning the potential leachability of Ra from MSW is not an objective of the propo sed*

plan or of the F&T analysis because the greater likelihood of potential future impacts to groundwater comes from the horizons with the most elevated concentrations, which are not expected to be MSW.